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REMARKS ON CLASSIFICATION OF VERTEBRATA.¹

BY BURT G. WILDER.

MANY classifications of animals present three general features:

(a) An approximate conformity to the prevailing idea that the kinds or grades of groups, the "categories" of the elder Agassiz, are limited to branch, class, order, family, genus, and species, with, in some cases, the recognition of intermediate grades,—*e.g.*, sub-class, superorder, etc.

(b) The division of a given group into an indefinite number of subdivisions, commonly more than two,—*e.g.*, of natural objects into three kingdoms; of animals into four, five, or seven branches; of vertebrates into five or more classes.

(c) The frequent discrimination of groups by characters which are neither constant nor peculiar, and derived from parts like the skeleton or limbs, which are easily preserved, examined, and described,—*e.g.*, Vertebrata, Chordata, Hyostylica.

The accompanying arrangement is partial, and in several respects provisional. It accords essentially with the more recent views of high authorities, but attention is called to the following features:

(a) It is wholly *dichotomous*.

(b) Several of the divisions are based upon the conditions of the *cavities* of the *central nervous system*.

(c) The new names refer to characters which are *constant* and *peculiar*, so that they are not merely designatory in a conventional sense, but *etymologically* and *descriptively correct*.²

(d) The names are largely *correlated* so as to suggest their antitheses.

The writer fully appreciates the undesirability of introducing new terms, and by no means urges the adoption of any here presented excepting as expressive and convenient substitutes for phrases.

¹ Read at the New York meeting of the American Association for the Advancement of Science, Aug. 12, 1887.

² On this point see the writer's "Educational Museums of Vertebrates," Amer. Assoc. Proc., 1885, p. 276.

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| SAUROPSIDA (= reptiles and birds); mesocœle laterally extended; roof bilobate. | MAMMALIA.—Mesocœle tubular; mesocœlian roof quadrilobate, forming two pair of optic lobes. |
| ANAMNIOTA = Branchiata = Amphibia + Dipnoi; aulic floor horizontal. | AMNIOTA = Abranchiata = reptiles, birds, and mammals; aulic floor approximately vertical. |
| MEGAULICA (aula large; cerebral hemispheres extended horizontally or undifferentiated); = Ichthyopsida—Amphibia, Dipnoi, and Branchiostoma. | MICRAULICA (<i>aula small</i> ; cerebral hemispheres extended vertically); = Amphibia, Dipnoi, reptiles, birds, and mammals. |
| MONOCELIA (encephalocœle single; neuron epaxal only; axon unsegmented); = Cephalochorda = Acrania = Leptocardia = Monolocularia = Branchiostoma. | POLYCELIA (<i>encephalocœle segmented</i> ; neuron partly preaxal; axon vertebrated) = Craniata = Pachycardia = Multilocularia. |
| CRYPTOCELIA (neurocœle transitory) = Ametamera = Urochorda = tunicates. | PHENOCELIA (<i>neurocœle persistent</i>) = metamera = Branchiostoma and other vertebrates. |
| STEREONEURA (nervous centre solid if present) = most "Invertebrates." | CÆLONEURA (neuron hollow) = Chordata (+ Enteropneusta?). |
| | METAZOA. |

Explanation of the Table.—The more comprehensive groups are below and their divisions above.

From the point representing a given group two lines diverge, forming what may conveniently be called a *furca*, or two-tined fork.

The vertical tines form part of a line of direct ascent to man. The oblique tines or branches extend to the left, and indicate groups not in the line of succession.

For convenience the *furcas* may be numbered from below upward, and the groups mentioned as *direct* and *oblique*, like the tines which represent them.

The only unfamiliar terms which are not self-explanatory are *mesocœle*, the cavity of the mesencephal, or segment of the optic lobes, and *aula*, the mesal division of the prosocœle, or cavity of the prosencephal. *Preaxal* and *epaxal* are synonymes of *prechordal* and *epichordal*. *Monolocularia* and *multilocularia* refer to the cardiac cavities.

For the sake of brevity the arithmetical signs +, —, and = (plus, minus, and equal) are employed.

General Features of the Scheme. Dichotomy.—The twofold division of groups is not new in practice, and is, as it seems to the writer, becoming more common,—*e.g.*, the primary division of animals into Protozoa and Metazoa in place of four or more “branches”; the primary division of vertebrates into Acrania and Craniota, and the combination of Reptiles and Birds as Sauropsida. But, apparently, there has not been hitherto a distinct recognition of dichotomy as a fundamental principle in natural classification, or an expression of doubt as to whether any group really comprises three or more equal and co-ordinate subdivisions. The writer’s view may be briefly stated as follows: *In any assemblage of three or more objects, individuals, or groups, two or more of these units are more nearly related to one another than to the third or the others, indicating a primary division of the entire assemblage.* Very commonly the basis for the distinction is the presence or absence of an organ, feature, or condition, whence arise positive and negative names, like *vertebrate* and *invertebrate*, *amniota* and *anamniota*, etc.

Irrespective of special facts, then, the writer has been led to doubt the naturalness of, for example, the popular subdivision of natural objects into three co-ordinate kingdoms, *animal*, *vegetable*, and *mineral*; of the chordata into *urochorda*, *cephalochorda*, and *vertebrates*; of vertebrates into *Ichthyopsida*, *Sauropsida*, and *Mammalia*, and of mammals into *Prototheria*, *Metatheria*, and *Eutheria*. Polychotomy is probably never more than provisional, and all classification will eventually be dichotomous.

The Morphological and Taxonomic Importance of the Central Nervous System.—The superior taxonomic value of the brain and heart was insisted upon by the writer in a paper read before this association in 1875; during the last seven years, as may be seen from various publications, he has become more and more impressed with the profound morphological significance of the presence and modifications of the *cavity* of the central nervous system, the *neurocæle*.

A neurocæle persists in all vertebrates, including Branchiostoma, and is present in the early stages of all Tunicates whose development is known. So far as the writer has been able to ascertain, the central nervous system is *neither tubular nor even grooved at any stage with any “Invertebrate,”* excepting the Tunicates, and, perhaps, *Balanoglossus*.

In accordance with the prevailing tendency to utilize the skeletal parts for taxonomic purposes, the vertebrates and Tunicates have been called *Chordata*, and *Balanoglossus* has been spoken of as a *Hemichordate*. Balfour regards the notochord as "the most characteristic organ of the Chordata."

In proposing to replace *Chordata* (a word, by the way, easily mistaken for the Latin *caudata*) by *Cœloneura*, the writer cares less for the adoption of the term than for the admission that soft parts are not only physiologically but morphologically more significant than hard; that the neuron is more important than the axon; and that *the cavity of the one is a more substantial basis for the primary subdivision of the Metazoa than is the entire mass of the other*.

Special Points and Queries.—Should it seem desirable to separate those Metazoa in which the nervous system is distinct from those in which none has been detected, it would only be necessary to interpolate between furcas one and two another, the two tines of which should stand respectively for *Neurica* and *Aneurica*, or equivalent terms; the *Neurica* would then comprise the *Cœloneura* and the *Stereoneura*.

The name *Vertebrata* is used only as a synonyme; if retained, there should be an understanding as to whether it shall exclude *Branchiostoma*, or include that form, or include the *Tunicates* as well.

Among the members of the oblique division of the fourth furca the Ganoids and Teleosts should be combined as fishes or Pisces, and distinguished from each other by the persistent and considerable cavities of the olfactory lobes with all Ganoids. Notwithstanding the writer's supposed observation (*Amer. Assoc. Proc.*, 1876, 258), these cavities are absent or insignificant in all Teleosts examined.

The association of the Amphibia with the Dipnoi is in accordance with the considerations presented in the writer's paper on the brain of *Neoceratodus*; see this journal, June, 1887, p. 544.

The characterization of the mesocœlian roof of the Sauropsida as *bilobate* may need qualification in view of Spitzka's observations on the interoptic lobes of some reptiles.

The primary division of the Mammals should, perhaps, be into the Eutheria and the others (implacentals). Something is to be said for either view, and it is to be hoped that the hearts

of typical implacentals, prepared by alinjection, may be carefully compared with each other and with those of representative Eutheria.

Historical Note.—It is proper to add that the idea of recognizing two antithetical groups according to the presence or absence of a neurocœle, was first formulated by the writer, under the names *cælianata* and *acælianata*, on a slip dated November 27, 1883; *cœloneura* and *stereoneura* are dated April 3, 1885. The passage on page 416 in Bell's "Comparative Anatomy and Physiology" (Philadelphia, 1885), commenting on the presence of a cavity in the nervous axis of chordata, was first seen March 13, 1886; but in January of that year, in lectures to students, and in a letter to Prof. J. H. Comstock, the general scheme of a dichotomous classification was presented in substantially the form here given.

SAND-BOULDERS IN THE DRIFT, OR SUBAQUEOUS ORIGIN OF THE DRIFT, IN CENTRAL MISSOURI.*

BY J. W. SPENCER, M.A., PH.D., F.G.S.

LOCATION.—During the winter of 1883–84 deep excavations were made in the Drift for foundations of additional buildings at the University of Missouri (lat. $38^{\circ} 57' N.$; long. $92^{\circ} 20' W.$). The altitude is seven hundred and thirty-six feet above the Gulf of Mexico. The University is near the southern margin of a rolling prairie, bounded by the large valley of the Hurkson Creek, excavated out of Lower Carboniferous limestones to a depth of one hundred and sixty feet.

2. *Geological Associations.*—The large valley dates back to the close of the Lower Carboniferous epoch. It was subsequently more or less occupied by deposits of the Coal-Measures, which have since been removed, except in some embayments and tributary ravines. Whilst these deposits are not found capping the limestone walls of the valley, yet remnants occur farther away, beneath the Drift-mantle, over the elevations of the rolling country, as shown in a well at the Gardens, just east of the University, where the Carboniferous shales have a thickness of

* Read before the New York Meeting of the American Association for the Advancement of Science.